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# The study of geometric forms, proportion and scale of heritage buildings due to architectural theory

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## Abstract

Architecture is the shapes of structure and enclosure that occurs from the elements of space organization patterns, space relationships and hierarchy, geometric shapes, scale ratio and proportion. In addition, architecture is the places of the programs from user requirements, user needs and aspirations, economic and social factors, cultural factor, the legality and the historical. Hence, from the building architectural styles, we could notify the history and the culture developments of a region. For example, Jakarta as a city has many buildings with different kinds of architectural style which varies according to the years or times when the building was erected. To get further, in Central Jakarta, there are many kinds of historical and monumental buildings. Thus, in this study, we choose the historical and monumental buildings types such as the Elephant Museum which is in the Dutch Colonial Architecture style, the Istiqlal Mosque which is in Modern Islamic Architecture style, the National Monument Building which is in Modern Architecture style, and the Cathedral Church which is in Neo-Gothic Architecture style. We use geometric operation methods to studying the form suitability with the spaces function and the golden section method to find the scale ratio and proportion of the building facades. The result of this research finds that when the aesthetic value of edifices conforms the architectural theory rules, it could produce a good design.

*Keywords:* architectural theory, geometric shapes, scale ratio and proportion, aesthetic value, golden section

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## 1. Introduction

Jakarta as a city has many buildings with different kinds of architectural style which varies according to the years and times when the building was erected. The old days, Jakarta has known as Batavia, and this old city has located in the heart of DKI Jakarta province, it calls Central Jakarta. Many historical buildings had been built in it, accordances with the development of Batavia to become Jakarta. And all these old buildings becomes a symbol or a main identity for the city of Jakarta itself nor for the Indonesian country. These buildings have become works of architecture's, where architecture defined as the shapes of structure and enclosure that occurs from the elements of space organization patterns, space relationships and hierarchy, geometric shapes and forms, scale and proportion. And in addition, architecture is the places of the programs from user requirements, user needs and aspirations, economic and social factors, cultural factor, and also the legalities and the historical. Also, based on the relation of theories and history, which is considered here, in relation to history is not so much as if they were in polar position, but rather as if they were in a figure-ground relationship; one helps to define the other. On this, admittedly simplistic analogy, theory is the figure and history is the ground just as history is the figure and the theory the ground from a historian's view, though the analogy ought not to be taken as implying that theory is grounded in history.

Therefore, it has courages the desire to study the aesthetic value of the architectural styles of all those buildings, with the theory of architecture as a based consideration. The aesthetic value that will be studied in this research is the composition of the building geometry shapes and forms in relation with the building function. Because, the basic shapes of the geometric forms has its own natures, scale and proportion. The final result of the building can be shown down by the ratio of scale and proportion calculation.

In this study, we choose the historical and monumental buildings types such as the Elephant Museum which is in the Dutch Colonial Architecture style, the Istiqlal Mosque which is in Modern Islamic Architecture style, the National Monument Building which is in Modern Architecture style, and the Cathedral Church which is in Neo-Gothic Architecture style. Those whole buildings are located in Central Jakarta which are near to each others. As we can see in figure 1 below at the map of the objects study location in Central Jakarta. These four buildings have has the same role meaning for the city of Central Jakarta, as a symbol, whether as a symbol of the history or the symbol of the building users.



Fig. 1. Object study location map & distance from each buildings

Based on historical records, all of those buildings were founded in varying with different origin architect. As we known : The Elephant Museum was established in 1862 by the Government of Hindia Belanda in accordance with the design of the Netherland architect that produces the European Classic Architecture style building. The Istiqlal Mosque was founded in 1961 by Sukarno, in accordance with the design of the Indonesian architect Frederich Silaban that produces the Modern Islamic Architectural style building. The National Monument was established in 1961 – 1975 by Sukarno, in accordance with the design of the Indonesian architects Frederich Silaban and R. M. Soedarsono, that produces the Modern Architecture style building. And last is the Cathedral Church was founded in 1899 by E. S. Luypen SJ in accordance with the design of the Netherland architect M.J. Hulswit, that produces the Neo-Gothic Architecture style building.

By the end of the eighteen century theory and practice were united in professional treatises that brought together rules of mathematics, proportion, ordering, geometry, and classical history with empirical studies and improve mechanical and technological understanding. Therefore, this research would like to give a review of the aesthetics value of the building if there is a conformity, and how geometric shapes give impact on the look of buildings as well as 3 dimensional shapes (form), and from the side of scale and proportions. The benefits of this research is to understand how the geometric forms, scale and proportion of edifices composing could give the aesthetics value, according book *The Secret of Architectural Composition* (Curtis, 2011). And how to figuring a scale and proportion ratio value, according to the Golden Section method that blend with Le Modulor that formulated in *Le Modulor* (2000) in Modern Architecture viewpoint (Corbusier, 2000).

## 2. Research theory

Architecture is only can achieved when there is wrought into the composition of the building a certain harmony of form which we call the beauty of edifice. It is this harmonious combining of elements according to the laws of art. Theorists agree in defining the basic principles on which the art of architecture rests. It is generally stated that the impression of beauty depends fundamentally on unity of form; or, in other words, that the plurality of elements that make up a building must be so related and bound together as to make what is termed as a unified composition. In order that this object be attained, it is evident that all these elements should bear, not only a definite relation to each other, but to the composition as a whole. The unity of the whole composition in architecture can be realized through understanding of the principles governing proportion and scale which fix the relation of parts to each other and to the entirety.

### *2.1. The natures and characteristics of the geometric shapes*

The nature of architecture is determined by two objects. The first of these objects is the satisfaction of the requirement of use; the second is the satisfaction of the requirement of beauty. Since the purpose of different types of building vary greatly, it follows that these two essential characteristics of use and beauty do not exist in the same degree, but alternate in importance within wide limits. Architecture viewed as 'like' nature in that it is similar to a natural organism in its harmony, character, and unity, or because its shapes and structure are based in natural forms and blend with nature, or imitate natural processes or outcomes – especially the nature that organizes things, reacts to environmental forces, gravitational forces, undergoes the mysterious process called growth, flowering, and seeding, then eventually decays only to start all over again. But, the mythical 'natural' essential shapes the creators of the modern movement were striving for did not belong to the realm of nature, but to the realm of culture. They were subject to history, and therefore they could not possibly be eternal. And they were and are subject to personal interpretation, which also means they cannot be eternal, unless one believe there is a quality that unites the nature seeking of wright and alto, which they both missed.

In architecture, geometry plays a role as quantitative control of the buildings harmony, so that the lack of it would make the building was vague and did not clearly defined. Thus, to possess unity a thing must be complete in itself. It must have a certain simplicity, easily grasped by the mind, which tends to produce singleness impression. The unity of the elementary geometrical solids, spheres, pyramids, cubes, cones and tetrahedrons, is readily comprehended, since nothing can be added to or taken away from any one of them without destroying its form. To these solids of geometry the larger masses of building bear a close correspondences since they have in general the same regular stereometric form, yet they differ from them in other essentials affecting their unity. These differences are due, first, to the fact that geometrical solids do not necessarily bear any relation to their surroundings and particularly to the ground on which they stand. The singleness of impression which is essential to unity in solid forms is a resultant of the method, system or idea controlling their generation. This produces other differences affecting the unity of the solids of architecture that are not to be found in the solids of geometry. Here, the singleness of impression results especially from the search for the character in the architecture has already been alluded to.

Character here means that every building should have an individual treatment or configuration that is primarily a direct result of the purpose for which it is intended and the materials which it is built. In other words the purpose for which a building is intended determines its character, first by determining its plan and outward configuration and second by expressing in it certain ideal significance which declares in the language of beauty the object and purpose for which it stands. So, that's why a factor of the geometric ratio or scale will dominating in the last architectural design process. Certain geometries and shapes, for instance, are accepted as having history of use and a symbolism by which their adoption brings particular meanings to a work of architecture, whether intended or not. These shapes are almost inviolate to the extent that, for some, the equivalent of desecration occurs if they are used without due reference or reverence. In most cases, through, the effect is less dramatic.

## 2.2. Proportion and Scale

Proportion plays an important role in all three, as it provides guidelines for laying out useful spaces, for designing structural systems, and for creating an aesthetically pleasing environment. The proportions of a space can dramatically change how visitors feel in it, and the proportions of a facade design can affect whether a building appears welcoming, threatening, or impressive.

Proportion is important as the order of architecture for usefulness, strength and beauty. Proportions in architecture are only referable to nature through the medium of “scale”. Scale is a sort of imaginary yardstick which is use to bring all the essential details of a building into harmonious proportion. Scale is an adjustment of these elements to the requirements of human beings and to certain limitations in the nature of material which are derived from usage, tradition and methods of construction and manufacture. In the study of composition, it must become more and more evident to that proportion, the relation of one part of a composition to another, constitutes very nearly all that is beautiful in any work of art. The proportion result are coming from the following consideration : proportions resulting from the mode of construction, proportions deduced from reasoning out the requirements of the program, traditional proportions – the result of usage and generally accepted taste. Thus, the considering that will follow is coming from traditional proportions – the result usage and generally accepted taste. This consideration will be use to see the conformity of the building that erected in classic architecture style and modern architecture style at central Jakarta. The determination of aesthetic value will be realm to the scale ratio of golden section method as an evident of the relation of one part of a composition to another. This method has develop using mathematics formula the fibonnaci series as an imaginary yardstick that created by Le Corbusier.

## 3. Research Methodology

The researchs finding in this research is raised from a question : to what extent does the aesthetic value of the building studied conform to the aesthetic rule in architecture theory? Accordance to the relationship of geometric, scale and proportion of heritage buildings. And chosen 4 building in Central Jakarta as cases study. Broadly speaking, this research is using qualitative methodology. Thus, this research will use the geometric composition and proportion and scale model to find the value, it will be determined using those 2 models. So far, the methodology of this qualitative research is shown in figure 7 below :

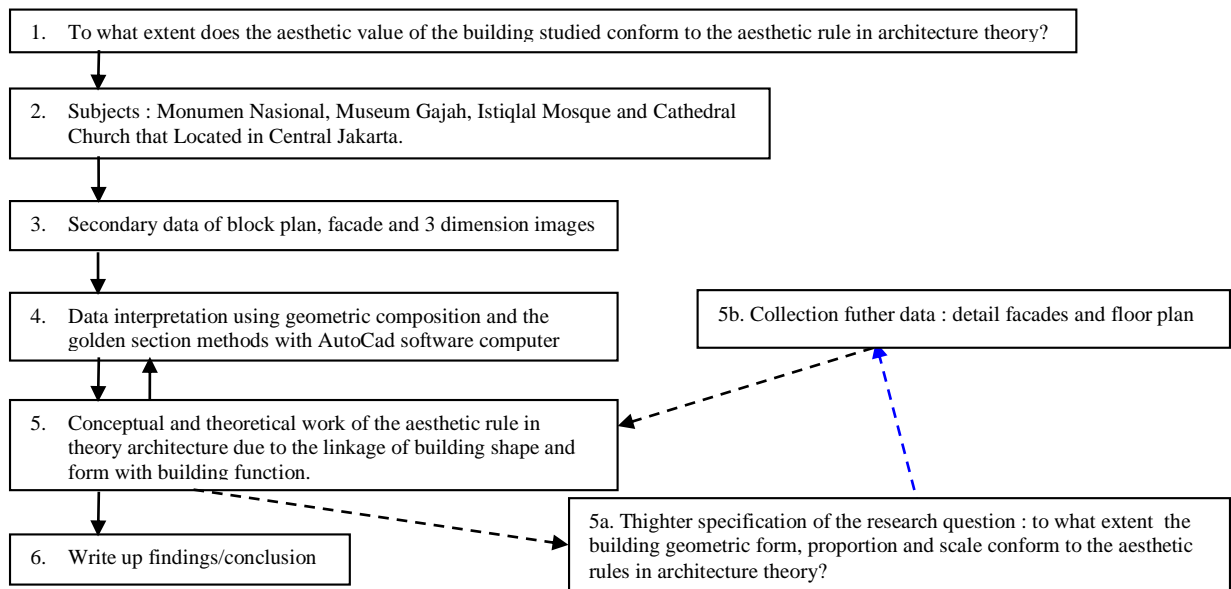


Fig. 7. Qualitative researchs methodology.

### 3.1. The Composition Method of The Geometric Form

The first factor upon which the appearances of a building depend is its mass. The silhouette of the mass will be the sole effect observable when a building is seen in reduced light or through a haze. This silhouette will be composed of one or more of the following four elements, depending upon whether the form or grouping is closed or open. The element of mass are : the principal mass, subordinate masses, links, appendages. The closed form is characteristic of tower, like structures of prismoidal or cylindrical mass, of highly monumental edifices usually of pyramidal form. Such types of building are produced by the development of the principal mass, alone or in combination with subordinate mass. In the open form grouping, the subordinate masses are detached from the principal mass. Connections then assume greater importance because they serve to unite the diverse elements of the composition into a single organic whole.

### 3.2. The Golden Section Method

The golden ratio, a common relationship of scale in nature, introduces order and creates harmony in visual art and architecture. The Golden section is a proportioning system that governs the relationship of smaller parts to the whole. It has long been believed to produce some of the most aesthetically pleasing shapes in nature, and as such has been used in many works of art and architecture. The ratio is  $AB:BC=BC:AC=1:1.618$  as shown in figure 8 :

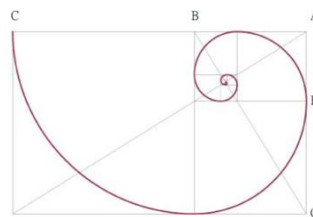


Fig. 8. The golden section method.

## 4. Result and Discussions

This is the result and discussion of researchs finding for the question : to what extent the aesthetic value from the relationship of geometric form, scale and proportion of four heritages buildings in Central Jakarta conform the architecture theory?

### 4.1. The Geometric Forms

The result of geometric forms study has proven the architectural theory that so much in this cases that shapes such as cruciform, the pyramid and ziggurat, the aedicule, the helix, and the dome are brimful of meaning arising particularly from their use in religious buildings accros culture. Almost all the geometric shapes forms have been using to represented a symbols.

#### a. The National Monument (Monas)

The Monas building function as a museum of Indonesian history with the planning concept based on the concept of *Lingga* and *Yoni* which are symbolizes the universal eternal couples, it also a symbol of fertility and the harmonious unity of all complementary Indonesian prehistoric. It have erected with base in square shapes in 45 meters long, it represented the independence years, then the *Yoni* as a feminine element which means passive and negative, has 17 meters high elevation from the base that represented the independence date. Above it, the towering obelisk symbolizes the *Lingga* with philosophy meaning as masculine elements that is active and positive. This obelisk has a basic square 8 metres long that represented the independence month. Then, the gold fire form which has philoshopy meaning as the Indonesian struggle for independence would last for ages. So, the closed form geometric has using to presented

all the symbolic meaning to this building. With the elements of mass are produced by the development of the principal mass in big square form geometric, and combination with subordinate masses small square forms geometric with cornice at the top below the fire organic form. As shown in figure 9 :

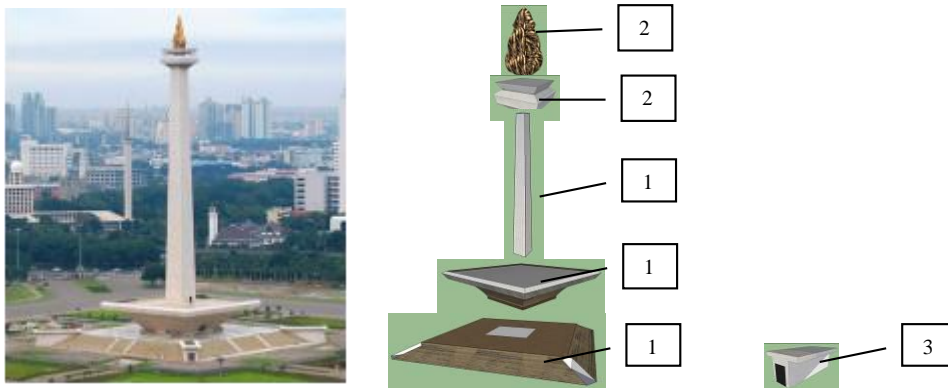


Fig. 9. (a) The Monas bird eye view (b) The closed form grouping masses : (1) the principal (2) the subordinate (3) the appendages

#### b. *The Elephant Museum (Museum Gajah)*

Indonesian National Museum also known as Elephant Museum was founded with the purpose as a places to store the objects or collections that can advance the research in the art and science fields, in particular fields of biology, physics, archaeology and history, as well as publishing the results of research. Then, in 1950 was renamed as Indonesian Cultural Institutions with the new slogan "advancing sciences cultural manifestation to increase knowledges of the Indonesian archipelago and the surrounding lands". It was built in the Colonialism Architecture with European Classic architectural style influences. Productes in open form grouping geometric with the principal mass in square forms that are arranged in U letter, the subordinate pyramidal mass are detached at the top of the square-shaped, it has an outdoor space at the midst of it as links and at the front facade there are the appendages pillars detached with the subordinate triangle roof as the Classic Architecture identity, as shown in figure 10 below :

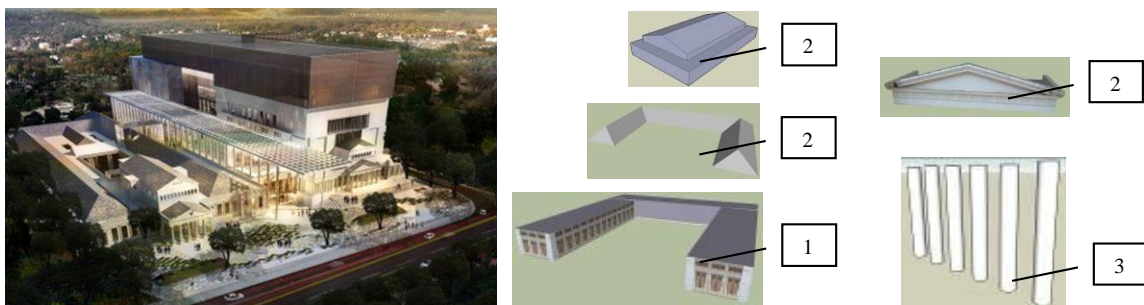


Fig. 10. (a) The Elephant Museum bird eye view (b) The open form grouping masses: (1) the principal (2) the subordinate (3) the appendages.

#### c. *The Istiqlal Mosque*

The Istiqlal Mosque was established as a gratitude expression to the Indonesian Moslem God (ALLAH), which was the idea had came out four years after the Indonesian freedom proclamation. Correspond to Indonesian traditions since ancient times that is always built a religious monumental building to symbolize the triumph of the Nation, such as Borobudur and Prambanan Temple. The Wihelmina Park is chosen as site location of this mosque acrossing the Cathedral Church, to symbolize the Indonesian religious life harmony. Istiqlal Mosque has creates in open form grouping geometric with square shape form as the principal mass, and have 5 rectangles as linked masses, and detached the subordinate dome mass at the roof top in many scale according to the principal mass scale. And also, there is a square-shaped outdoor space as a open areas. There also an appendages cylinder mass which is in needle's form



detached to symbolize the verticality. This Istiqlal Mosque forms are in Modern Islamic Architecture style with geometric forms composition methods as shown in figure 11 below :

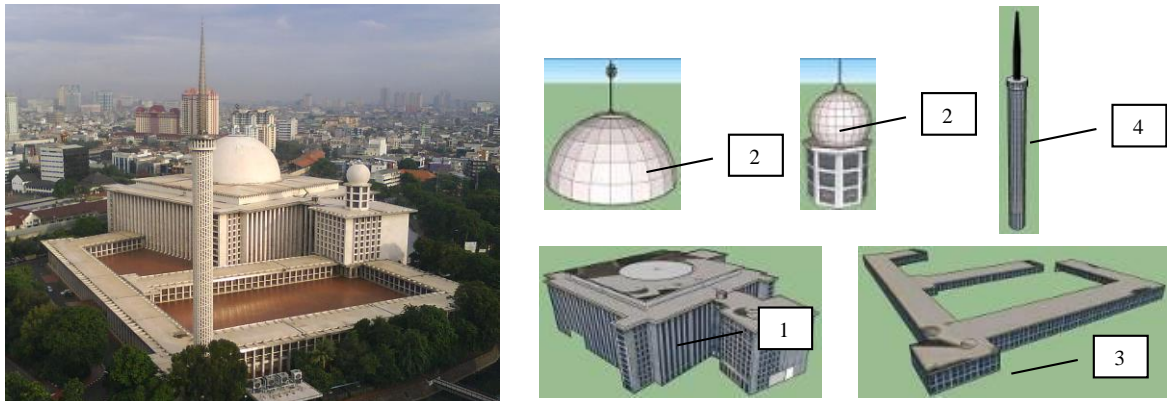


Fig. 11. (a) The Istiqlal Mosque bird eye view (b) The open form grouping masses: (1) the principal (2) the subordinate (3) the linkage (4) the appendages.

#### d. The Cathedral Church

The Cathedral Church building is in Neo-Gothic Architecture style, the simplified of Gothic characteristic. Stay on using the pointed arch shapes to the doors and windows. There are appendages pilasters that semblances of the flying buttress. Produced in closed form geometric mass which consists of rectangles form as the principal mass. There are the appendages smaller rectangles detached on the left and right at the floor plan body. And there also, the appendages that consist of  $\frac{1}{2}$  circle form's which is the continuation of the rectangles body detached at the floor plan head. Then, it's get more appendages with small rectangles and  $\frac{1}{4}$  circles forms on the left and right side at the end of head. Continues to the roof top, there are subordinates pyramidal and cone's forms are detached with the tower needle forms as the verticality. We can see the geometric composition methods as shown in figure 12 below :

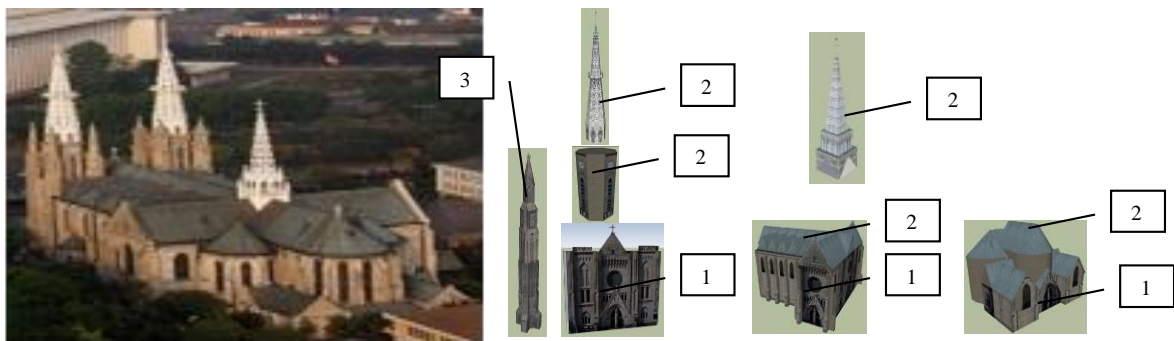


Fig. 12. (a) The Cathedral Church bird eye view (b) The closed form masses: (1) the principal (2) the subordinates (3) the appendages.

From those geometric forms decomposition, we can learn how to produces the aesthetic value from composing the geometric form according to get the silhouette of building appearances. Indeed, all the geometric form composition methods have conform to the theory of relation of the whole “Beauty will result from the form and correspondence of the whole, with respect to the several parts, of the parts with regard to each other, and of these again to the whole; that the structure may appear an entire and compleat body, wherein each member agrees with the other, and all necessary to compose what you intend to form”.

#### 4.2. Proportion and Scale

“The meanings such elements carry is a product of the associative power of the figural in architecture. Architects today no longer ideologically oriented but are visually oriented; they are not in the sociology business but in the imaging business”. The study of scale and proportion using the golden section methods with the fibonacci series rectangles models to find aesthetic value ratio from the human ability to focus on and perceive details is restricted to a fairly narrow cone of vision. Thus, the aesthetic value in this research focus on the impression that delivered by the geometric form composition of scale and proportion in silhouette appearances at front facades with traditional proportions – the result of usage and generally accepted taste - consideration.

##### a. The National Monument (Monas)

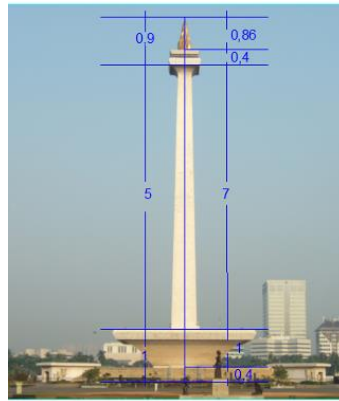


Fig. 13. Ratio of scale and proportion of Monas.

From figure 13, we can see that Monas proportion and scale ratio resulting came out with monumental scale ratio 1: 5 : 0,9 and also not follow the golden section ratio. This Monumental building stand alone with others building around it becoming as the wings. The building proportion in symetrical balance and have one central axis. It conform with the theory that in buildings of monumental character the impression of unity is realized without effort of the intellect. Such buildings are usually symmetrical with a dominating central portion flanked by wings.

##### b. The Elephant Museum (Museum Gajah)

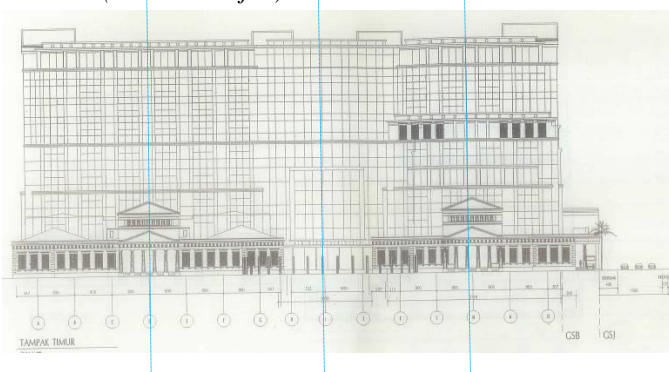


Fig. 14. The Elephant Museum Front Elevation.

From figure 14, we can see the front elevation of Elephant Museum facades which is have 3 central axis from the principal masses. The proportion is not symmetrical and also not balances, thus this geometric form proportion not conforms to the classic architecture concepts that always planning in symmetrical proportions.



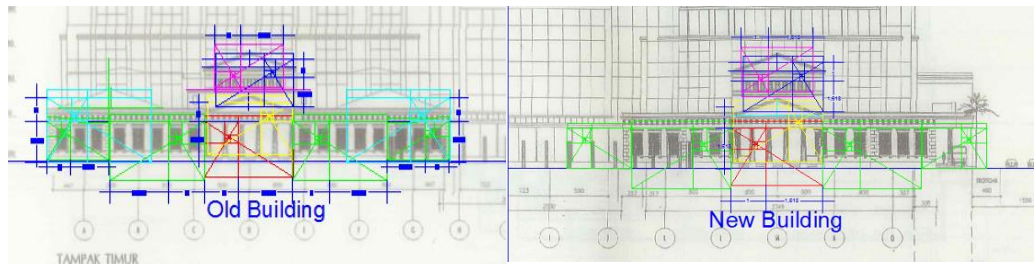


Fig. 15. Scale and Proportion ratio (a) Old Building facades (b) New Building facades.

And in figure 15, on the left side was the old building facades which is conformed to the golden section ratio, because all the elements proportion of openings modular repetition, roofs, columns and cornices approach the ratio 1:1.618. But, on the new building, although the design according to the old building, the elements proportion such as window modul repetition, roof, columns, cornices no conforming to the golden section ratio. Also, the new highrise building behind the old building, the forms proportion not balances and not conforming to the old building proportion composition. So, there is a contrast in this building facades.

#### c. The Istiqlal Mosque

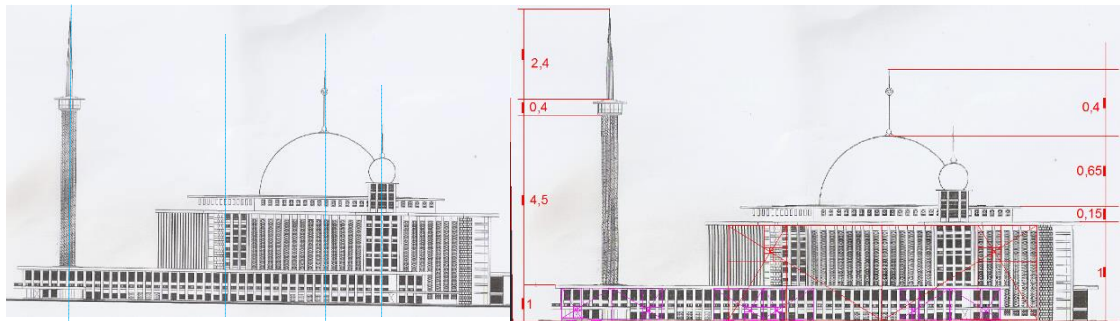


Fig. 16. (a) The Istiqlal Mosque Elevation from the Cathedral Church (b) Scale and Proportion ratio.

In figure 16 (a) we can see the Istiqlal mosque front facades composing have 4 central axes from the principal masses. Those are squares and domes geometric at the right with symmetrical balances proportion, on the front there are mihrab in needle forms and cylindrical-domes forms on the top of rectangular links forms which is in symmetrical proportion. And the whole proportion is not balance in scale and proportion based on visual weight, because the density of visual weight on the right side is bigger than on the left side. And in figure 16 (b) also we can see that the proportion and scale ratio not conform to the golden section ratio which is comparison 1:1,618. It caused by the repetition of the windows or the openings modul that are not balances in continuation. There is a modul that consist of 5 openings, but there is also a modul that consist of 4 or 6 openings. Then, the scale ratio and proportion at the principal masses squares and domes, where the body and foot is bigger than the roof that is 1 : 0,8. Continues to the scale and proportion of the link masses, where the body and foot are smaller than the head (mihrab tower) that is 1 : 7,3. Therefore, there is an ambiguous in conformity of using monumental scale.

#### d. The Cathedral Church

In figure 17 (a) we can see the Cathedral Church front facades composing have 3 central axes from the principal masses. Those are the rectangles and cone forms in symmetrical proportion and balances in monumental scale. And from figure 17 (b) we can see the differences of the left pinnacles (David Battlements) and the right pinnacles (Ivory Tower) ornaments. There are conformity of the proportion and scale ratio of the windows modular, the fortress that approach the golden section ratio which is 1 : 1.618. But, there is a discrepancies in the proportion on the mids where

the Angelus Dei Tower resting on top of it, at line head starting point on the entrances head section that not aligned with the starting point of the left and right pinnacles line head.

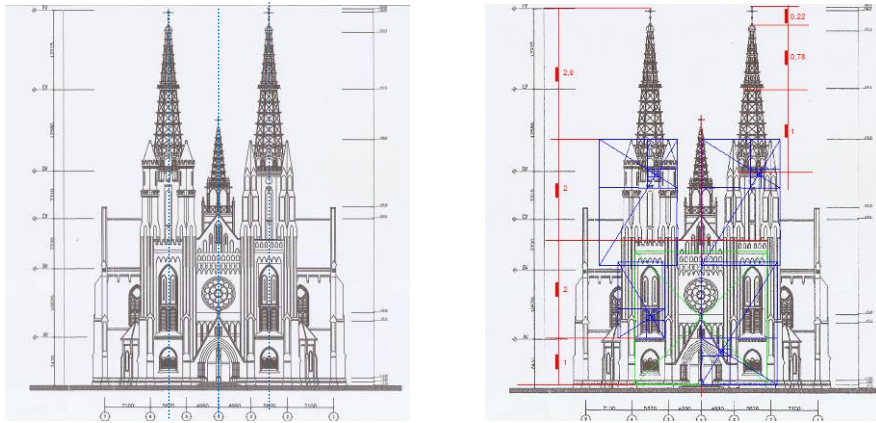


Fig. 17. (a) The Cathedral Church Front Elevation (b) Scale and Proportion ratio.

## 5. Conclusions

This research studying 4 heritages buildings geometric forms composing in Central Jakarta, in order to finds the aesthetic value of the building silhouette that can be created by the geometric composition which is considering the proportion and scale ratio that could visualize by peoples who sees the building, they are : the Monas, symbolize the Indonesian spirit in struggle; the Elephant Museum, symbolize the Indonesian spirit to learned; the Istiqlal Mosque, symbolize the Indonesian spirits to show their gratitudes to ALLAH; and the Cathedral Church, the symbolize of the christian life's spiritualism. And when the geometric composition conform the aesthetic rule in theory architecture, it could produces the good design, congruence with the theory in definition of good design "an object is well designed where the relationship of the part to the part and of the part to the whole shall appear to be inevitable".

And we can conclude that the proportion and scale ratio of edifices in the monumental scale could creates only when it conform the theory architecture which is to composes the geometric form composition in closed form method. Because, if the monumental edifices composition in open form grouping, it could arousing an ambiguity. This result have congruence with the architectural theory that poses by Leon Batista Alberti (1755a:1.1) that mentioned that it is the property and business of the design to appoint to the edifice and all its parts their proper places, determinate number, just proportion and beautiful order; so that the whole form of the structure be proportionable. And also, the composition of function and duty of the openings modulars, the columns and pilars, according to the harmony repetition could give influence to the visual weights balances of the facades proportion.

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